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Summaries of Herbicide Trials for Pasture, Range, and Non-Cropland Weed Control—1999

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The tables herein summarize herbicide trials for the control of pasture, range, and non-cropland weeds conducted by the College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa; the Hawaii Department of Agriculture; the Division of Forestry and Wildlife of the Hawaii Department of Land and Natural Resources; and other cooperators. These preliminary data are published to assist applicators experimenting with herbicides for weed control. The herbicide applicator is cautioned to confirm that any herbicide use, rate, or method of application conforms to the product label.

Rating weed response to herbicides

Weed response to treatment is evaluated by different methods. Plant injury may be scored on a 0–100 scale in which the score is a subjective evaluation of the severity of injury:

0	No symptoms
10–30	Insignificant to poor weed control; little or no defoliation
40–60	Inadequate weed control; moderately severe symptoms; less than 70% defoliated
70	Adequate weed control; severe symptoms; all leaves chlorotic or more than 70% defoliated
80	Good weed control; very severe symptoms; 80% defoliated
90	Excellent weed control; very severe symptoms; 90% defoliation
100	Complete control; no sign of life

In addition to the scale described above, efficacy of treatments may be determined by estimation of defoliation or its opposite, remaining weed cover. The method used depends on the growth habit of the weed. Response may also be measured by counting the number of surviving plants or stems, by measuring weed height, or a combination of these.

Methods of herbicide application

Foliar

See: Motooka, Philip, Guy Nagai, and Lincoln Ching. 1982. Weed and brush control in pastures and ranges of Hawaii: I. Foliar application of herbicides. HITAHR Brief 16. CTAHR. 6 p.

Basal bark and basal stump

See: Motooka, Philip, Guy Nagai, and Lincoln Ching. 1982. Weed and brush control in pastures and ranges of Hawaii: II. Basal bark method of herbicide application. HITAHR Brief 17. CTAHR. 3 p.

Cut-surface

See: Motooka, Philip, Guy Nagai, and Lincoln Ching. 1982. Weed and brush control in pastures and ranges of Hawaii: III. The notching method of herbicide application. HITAHR Brief 18. CTAHR. 4 p.

Soil application

See: Motooka, Philip, Guy Nagai, and Lincoln Ching. 1982. Weed and brush control in pastures and ranges of Hawaii: IV. Soil application of herbicides. HITAHR Brief 19. CTAHR. 3 p.

Drizzle application

See: Motooka, P., G. Nagai, and L. Ching. 1983. The "magic wand" method of herbicide application. Proc. Ninth Asian Pacific Weed Sci Soc. Conf. Suppl. Vol. p. 550–553; Motooka, P., J. Powley, M. DuPonte, L. Ching, G. Nagai, and G. Kawakami. 1999. Drizzle herbicide application for weed management in forests. Proc. West. Soc. Weed Sci. 52:136–139.

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Herbicides tested

Chemical	Trade name and manufacturer
Azafenedin	Milestone (DuPont)
Bromacil	Hyvar X (DuPont)
2,4–D	Amine salt formulation, various brands.
	Ester formulation, various brands.
Dicamba	Banvel (BASF).
Diuron	Karmex (DuPont)
Glyphosate	Rodeo (Monsanto).
	Roundup (Monsanto).
Hexazinone	Pronone Power Pellets (DuPont)
	Velpar L (DuPont)
Imazapyr	Stalker (American Cyanamid).
Isoxaben	Gallery (Dow AgroSciences)
MCPA	MCP Amine (Clean Crop)
Metsulfuron	Escort (DuPont)
	Ally (DuPont)
Napropamide	Devrinol (United Phosphorus)
Norflurazon	Solicam (Novartis)
Oxadiazon	Chipco Ronstar G (Rhone–Poulenc)
Prodiamine	Endurance (Novartis)
Triclopyr	Garlon 4 (Dow AgroSciences).
	Remedy (Dow AgroSciences)).
	Redeem (Dow AgroSciences).
	Pathfinder II (Dow AgroSciences).
Tebuthiuron	Spike 20P (Dow AgroSciences)
Trifluralin + isoxaben	Snapshot 2.5 TG (Dow AgroSciences)

Weeds

Black wattle *Acacia mearnsii* DeWilld.
Hairy abutilon *Abutilon grandifolium* (Willd.) Sweet
Shoebutton ardesia *Ardesia elliptica* Thunb.
Bamboo *Phyllostachys niger* [(Lodd.) Munro var. *henionis* (Mitf.) Rendle]
Buffelgrass *Cenchrus ciliarus* L.
Highbush blackberry *Rubus argutus* Link
Bushy beardgrass *Schizachyrium condensatus* (Kunth) Nees
Common Australian buttercup *Ranunculus plebeius* R. Br. ex DC
Catsclaw *Caesalpinia decapetala* (Roth) Alston
Christmasberry *Schinus terebinthifolius* Raddi
Common mullein *Verbascum thapsus* L.
Daisy fleabane *Erigeron karvinskianus* DC
Downy rosemyrtle *Rhodomyrtus tomentosa* (Aiton) Hassk.
Fayatree *Myrica faya* Aiton
Fountaingrass *Pennisetum setaceum* (Forssk.) Chiov.
Gorse *Ulex europaeus* L.
Formosan koa *Acacia confusa* Merr.
Guava *Psidium guajava* L.
Strawberry guava *Psidium cattleianum* Sabine
Joee *Stachytarpheta dichotoma* (Ruiz&Pav.) Vahl.
Lambsquarters *Chenopodium album* L.
Lantana *Lantana camara* L.
Melastoma *Melastoma candidum* D. Don.
Pickleweed *Batis maritima* L.
Mysore raspberry *Rubus niveus* Thunb.
Yellow Himalayan raspberry *Rubus ellipticus* Sm.
Wild olive *Olea europaeus* L.
Wild strawberry *Fragaria vesca* L.
Wedelia *Wedelia semitriloba* (L.) Hitch.

Observations

Shoebutton ardesia was not adequately susceptible to drizzle applications of MCPA or triclopyr in water but was marginally susceptible to triclopyr in crop oil. Ardesia seedlings were virtually eliminated in all herbicide treatments (Table 1). Bushy beardgrass was very susceptible to hexazinone applied as a single large pellet per plant (Table 2). However, because hexazinone is nonselective and persistent, and given the density of beardgrass infestations, its utility in pastures and forests is problematical. Common Australian buttercup was sensitive to MCPA and to dicamba applied by conventional spraying (Table 3). Christmasberry trees were very sensitive to soil applications of tebuthiuron pellets at 2 kg/ha in both broadcast and grid (hot spot) applications (Tables 4, 5). Downy rosemyrtle proved rather tolerant of triclopyr applied by conventional spraying and by drizzle application in water or oil carriers, suggesting higher rates may be necessary (Table 6). Downy rosemyrtle was more susceptible to triclopyr applied by very-low-volume basal bark applications of triclopyr in oil and applied to opposite sides of the main stem, although repeat applications were required (Table 7).

Faya tree was moderately sensitive to drizzle applications of triclopyr in water or in oil (Table 8). Repeat applications may provide adequate suppression as the canopy density is reduced by prior treatments. Formosan koa trees treated by very-low-volume basal bark applications on opposite sides of the basal stems declined slowly. Trees with basal diameters of 3 inches or less

were essentially defoliated 19 months after treatment (MAT) (Table 9). Larger trees apparently require higher doses.

Fountaingrass proved tolerant of glyphosate applied by the drizzle method but was sensitive to glyphosate at 2 kg/ha applied by conventional spraying (Table 10). The fountaingrass was somewhat rank at the time of treatment. More succulent plants, e.g. young regrowth after fires, may be more amenable to control by the drizzle method. Using adjuvants Silwet L–77™ and Nu Film™ and doubling the volume rate did not increase efficacy of glyphosate on fountaingrass (Table 11). Fountaingrass was initially suppressed by preemergence herbicides (Table12). The plots remained relatively clean for 7 months. However, the plots, including the check plots, were also clean because of drought and grazing by feral goats.

Guava was sensitive to repeat drizzle applications of triclopyr in crop oil, less so to MCPA or triclopyr in water (Table 14). Strawberry guava was likewise more sensitive to drizzle application of triclopyr in oil than to triclopyr in water (Table 15). Strawberry guava trees were also susceptible to very-low-volume basal bark treatment of triclopyr in oil (Table 16).

Joee was very susceptible to MCPA applied by conventional spraying but tolerant of drizzle-applied triclopyr in water or in oil (Table 17). Lantana was moderately sensitive to glyphosate at 1 kg/ha, less so to 0.5 kg/ha at 15 and 30 liters/ha volume rate; however, more time is required to ascertain the full effect of glyphosate (Table 18). Lantana was susceptible to applications of hexazinone in spots near the base of the target plants (Table 19). Lantana was also susceptible to soil-applied tebuthiuron at 4 kg /ha, less so to 2 kg/ha (Table 20). Yellow Himalayan raspberry was sensitive to triclopyr at 0.5 and 1.0 kg a.i./ha in water or in oil. At 6 months after treatment, recovery was further along with the lower rate and with the water-carrier treatment (Table 21). However, this may not be a problem if repeat treatments are made. Because of the large brambles, complete kill in one application is probably not possible, and a repeat application will get weeds that were missed in the prior application or those that recently germinated.

Plots on Lahaina Pali Trail on Maui were treated with tebuthiuron pellets and hexazinone applied by the drizzle method to evaluate these herbicides for long-term weed suppression, primarily of buffelgrass, which can obliterate the trail and create a fire hazard. Because rains are irregular in the area, evaluations can be made only after rains. At 6 months after treatment, hexazinone was very effective in suppressing weeds, and tebuthiuron provided 50% control over the check (Table 13). The ineffectiveness of tebuthiuron was probably because of sparse distribution of the pellets. Repeat applications may increase efficacy of both herbicides, i.e., two annual applications may provide several years of control. Preemergence herbicides were evaluated in an outplanting nursery to establish native plants in forests. Because of a heavy litter left behind after clearing, weed infestations were light. Nevertheless, azafenedin showed promise in suppressing weeds in forest replantings (Table 22). Wedelia proved tolerant of 2,4-D, MCPA, and triclopyr applied by the drizzle method (Tables 23, 24). The weather was dry, and this may have contributed to the poor response, although no drought-related wilting was apparent.

Table 1. Response of shoebutton ardisia to MCPA and triclopyr (G99–12).

Date installed: 07/12/99. Date rated: 10/25/99. Location: Princeville, Kauai. Investigators: L. Ching, G. Nagai, P. Motooka. Notes: 21 ft by 50 ft plot drizzled with MCPA, triclopyr in water, triclopyr in crop oil, each at 1 kg/ha. Ten 1-m^2 subplot evaluated along transect in each plot. Injury rating visual, 100% = kill. Difference in ardesia density was in seedlings in check plots.

Treatment	Injury rating (%)	Plants/m^2
Check	0	18
MCPA	36	2.3
Triclopyr/water	40	1.0
Triclopyr/crop oil	71	2.4

Table 2. Bushy beardgrass response to soil applications of hexazinone (G99-13).

Date installed: 07/12/99. Date rated: 09/13. Location: Princeville, Kauai. Investigators: L. Ching, G. Nagai, P. Motooka. Notes: One pellet applied by hand to each plant.

Treatment	Defoliation (%)
Check	0
Hexazinone	91

Table 3. Buttercup control with MCPA and dicamba (K99-4).
Date installed: 04/09/99. Location: Waimea. Investigators: Glen Fukumoto, P. Motooka. Cooperator: V. In.

Herbicide	Rate (kg/ha)	Injury rating (05/07)	(06/17)
Check	0	6	0
MCPA	1	64	90
Dicamba	1	78	78
Dicamba + MCPA	0.5 + 0.5	79	89

Table 4. Christmasberry control by broadcast application of tebuthiuron (V97-18).
Date installed: 09/29/97. Date rated: 10/14/99. Location: Kaupo Ranch. Investigators: J. Powley, A. Franco, P. Motooka. Notes: Tebuthiruon applied with fertilizer spreader on both sides of transect, 30 ft wide total x 30 ft long, 3 plots.

Plot	Number of trees	Defoliation (%)	Kill (%)
1	5	100	100
2	11	89	45
3	3	99.5	67

Table 5. Christmasberry control by hotspot application of tebuthiuron (V99-19).
Date installed: 09/29/97. Date rated: 10/14/99. Location: Kaupo Ranch. Investigators: J. Powley, A. Franco, P. Motooka. Notes: 0.25 oz per inch stem diameter, up to 8 spots per plant. Target trees 8–35 in. basal diameter.

Number of trees	Defoliation (%)	Kill (%)
12	99.5	50

Table 6. Downy rosemyrtle response to triclopyr applied by spray and drizzle (G99-1).
Date installed: 01/11/99. Location: Wailua, Kauai. Investigators: G. Nagai, L. Ching, P. Motooka. Notes: Rosemyrtle 1 m tall, after mowing. Triclopyr applied at 1 kg a.e./ha (1 qt/A). Reapplication on 07/20.

Adjuvant	Method	Defoliation (%) 4/08/99	7/13	9/13
Check	-	0	0	5
Oil (1/2 %)	Spray	20	3	32
Oil (1/2%)	Drizzle	48	9	16
Oil (100%)	Drizzle	62	35	48

Table 7. Clearing downy rosemyrtle on trails by very-low-volume basal bark applications of triclopyr (G97-27).
Date installed: 10/30/97. Location: Wailua, Kauai. Investigators: G. Kawakami, L. Ching, G. Nagai, P. Motooka. Notes: 20% triclopyr ester in crop oil. Two pass treatments applied from opposite directions. Re–applied 05/21/98, 05/05/99.

Treatment	Defoliation (%) (01/28/98)	(04/27)	(08/12)	(02/22/99)	(07/13)
Check	11	22	5	0	8
One pass	35	18	40	12	42
Two passes	54	25	84	62	89

Table 8. Response of fayatree to triclopyr applied by the drizzle method in water and in oil (K99-9).
Date installed: 05/28/99. Location: Keauhou Ranch. Investigators: M. du Ponte, P. Motooka. Notes: Retreated 11/09/99

Triclopyr rate (kg/ha)	Carrier	Defoliation (%) 09/08/99	11/09/99
0.5	water	38	38
0.5	oil	48	53
1.0	water	55	42
1.0	oil	54	59

Table 9. Formosan koa control by VLV basal bark application of triclopyr (G98–2).
Date installed: 10/30/97. Date rated: 05/21/99 Location: Wailua. Investigators: L. Ching, P. Motooka, G. Nagai Cooperator: J. Sanchez. Notes: 20 % triclopyr ester in crop oil applied with drizzle applicator through a 10 ft swath of a Formosan koa stand in 2 opposite directions to provide 4 streaks each on opposite sides of the basal stems. Each plant in center 5 ft wide transect evaluated for defoliation by stem basal diameter class.

Stem diameter(inches)	Defoliation (%)	No. of plants
<2	99	23
2–3	91	15
>3	55	4

Table 10 Fountaingrass response to spray and drizzle applications of glyphosate (K98-11).
Date installed: 12/28/98. Location: Puuanahulu. Investigators: P. Motooka, G. Nagai. Cooperator: DLNR. Notes: Fountaingrass were rank at application.

Rate (kg/ha)	Method	Defoliation (%) (3/30)	(7/6)
Check		20	20
1	Spray	51	69
2	Spray	75	85
3	Spray	64	58
1	Drizzle	25	35
2	Drizzle	44	42
3	Drizzle	49	48

Table 11. Fountaingrass response to drizzle applications of glyphosate at different volume rates and with two different surfactants (K99-1).
Date installed: 03/30/99. Date rated: 05/07/99. Location: Puuanahulu. Investigators: G. Nagai, P. Motooka. Cooperator: DLNR. Notes: Twin nozzles fitted with two #20 orifice disks. One #30 orifice disk equals output of two #20 disks. Fountaingrass were rank at application.

Rate (kg/ha)	Volume rate (L/ha)	Surfactant	Defoliation (%)
0	0		57
0.5	15	Silwet L–77	60
	15	NuFilm	67
1.0 (Twin# 20 disks)	30	Silwet L–77	73
	30	NuFilm	73
1.0 (#30 disk)	30	Silwet L–77	67
	30	Nufilm	63

Table 12. Long-term suppression of fountaingrass on non-cropland (K98-12).
Date installed: 12/28/98. Location: Puuanahulu. Investigators: P. Motooka, G. Nagai. Cooperator: DLNR. Notes: Weeds present: fountaingrass, lambsquarters, mullein.

Herbicide	Rate (kg/ha)	Weed cover (%) (3/30)	(07/06)[1]
Check	0	22	4.5
Bromacil	5	8	3.8
Diuron	5	6	4.8
Hexazinone	5	1	1.2
Norflurazon	7	7	5.5
Tebuthiuron	4	4	2.2

[1]Drought. Feral goats grazed plots.

Table 13. Preemergence weed control on an arid trail (V98-5).
Date installed: 12/01/98. Location: Lahaina Pali Trail. Investigators: G. Shishido, J. Powley, P. Motooka. Notes: Hexazinone applied by drizzle, tebuthiruon granules applied by fertilizer spreader, each at 2 kg a.i./ha. Vegetation primarily buffelgrass.

Treatment	Weed cover (%) (05/04/99)
Check	68
Tebuthiruon	32
Hexazinone	6

Table 14. Guava control by drizzle applications of MCPA and triclopyr (G99-3).
Date installed: 02/02/99. Location: Wailua. Investigators: G. Nagai, L. Ching, P. Motooka. Notes: Herbicides applied at 1 kg/ha, SVR 15 l/ha; reapplied 07/20/99.

Treatment	Defoliation (%) (05/18/99)	(07/13)	(10/25)
Check	8	2	0
MCPA	37	47	53
Triclopyr/water carrier	69	57	68
Trilopyr/crop oil carrier	82	66	92

Table 15. Response of strawberry guava to drizzle applications of triclopyr in water and in oil (K99-8).
Date installed: 05/14/99. Location: Kurtistown. Investigators: M. DuPonte, P. Motooka. Notes: Triclopyr applied at 1 kg/ha.

Carrier	Defoliation (%) 11/18/99
Water	40
Oil	61

Table 16. Response of strawberry guava to very-low-volume basal bark application of triclopyr. (G98-9).
Date installed: 10/20/98. Date rated: 10/26/99. Location: Kokee. Investigators: G. Kawakami, G. Nagai, L. Ching, P. Motooka. Notes: Size class based on basal diameter. Application made in 4, 6, and 8 streaks on each opposite side of trunk.

Size class (inches)	Streaks per side	Defoliation (%)	Kill (%)
4	4	70	30
4–8	6	86	30
8+	8	98	60

Table 17. Control of joee by MCPA and drizzle applications of triclopyr (G99–5).
Date installed: 03/01/99. Date rated: 04/05/99. Location: Kapahi. Investigators: L. Ching, G. Nagai, P. Motooka. Notes: All herbicides applied at 1 kg/ha 1 qt/A).

Herbicide	Method	Defoliation (%) (04/05)	Defoliation (%) (06/03)
Check		0	9
MCPA	spray	89	100
2,4–D	spray	89	100
Triclopyr/water	drizzle	59	22
Triclopyr/oil	drizzle	65	66

Table 18. Spray volume rate effect on lantana response to drizzle application of glyphosate (K99-20).
Date installed: 07/06/99. Location: Keaukaha. Investigators: M. du Ponte, P. Motooka. Notes: 30 l/ha volume applied with twin #20 disks.

Glyphosate rate (kg/ha)	SVR (L/ha)	Defoliation (%) 11/18/99
0	0	0
0.5	15	51
0.5	30	51
1.0	15	75

Table 19. Lantana response to hot spot applications of hexazinone (K99-12).
Date installed: 06/24/99. Location: Keaukaha. Investigators: M. DuPonte, P. Motooka. Notes: Hexazinone applied with drizzle applicator in hot spot applications to base of target plants.

Treatment (spots/plant)	Defoliation (%) (11/18/99)
Check	0
1 (3 ml)	57
2 (6 ml)	66
3 (9 ml)	87

Table 20. Response of lantana to soil applications of tebuthiuron (K99-11).
Date installed: 06/24/99. Location: Keaukaha. Investigators: M. DuPonte, P. Motooka.

Tebuthiuron rate (kg/ha)	Defoliation (%) 09/08/99
2	57
4	88

Table 21. Response of yellow Himalayan raspberry to drizzle applications of triclopyr in water and in oil (K99-10).
Date installed: 05/28/99. Location: Volcano. Investigators: M. DuPonte, P. Motooka. Notes: Reapplication on 11/09/99.

Triclopyr rate (kg/ha)	Carrier	Defoliation (%) 09/08/99	Defoliation (%) 11/09/99
0.5	Water	70	48
0.5	Oil	73	70
1.0	Water	78	63
1.0	Oil	99	88

Table 22. Preemergence herbicides for forestry nurseries (G99-6).
Date installed: 03/15/99. Location: Kokee. Investigators: C. Koga, G. Nagai, P. Motooka. Notes: Most weeds were vegetative shoots of blackberry, daisy fleabane, wild strawberry.

Herbicide	Rate (kg product/ha)	Weed cover (%) (05/18/99)
Check	0	18
Oxadiazon	200	10
Snapshot	200	18
Prodiamine	2.3	16
Isoxaben	1.3	14
Azafenedin	0.94	5
Napropamide	12	18

Table 23. Wedelia response to drizzle applications of 2,4-D and MCPA (G99-10).
Date installed: 05/19/99. Location: Wailua. Investigators: L. Ching, P. Motooka, G. Nagai. Notes: Herbicides applied at 1 kg/ha.

Herbicide	Defoliation (%) 07/12	09/13
Weedar	40	37
HiDep	30	47
MCPA	15	8
Check	5	7

Table 24. Wedelia response to drizzle applications of triclopyr in water and oil carriers (G99-11).
Date installed: 05/19/99. Location: Wailua. Investigators: L. Ching, G. Nagai, P. Motooka. Notes: Triclopyr applied at 1 kg/ha.

Triclopyr rate (kg/ha)	Carrier	Defoliation (%) 07/12	09/13
Check		13	20
0.5	water	40	25
1.0	water	37	35
0.5	crop oil	32	25
1.0	crop oil	40	75

Table 25. Results of demonstration trials.

Weed	Herbicide	Rate or concentration	Method	Control (%)	Reps	Duration (mo.)	Site
Abutilon, hairy	Tebuthiuron	2 lb/a	Soil	75	1 plot	24	Kaupo
Bamboo	Glyphosate	50%	Basal	40	1 plot	3	Kona
Bamboo (re-sprouts)	Glyphosate	1 kg/ha	Drizzle foliar	80	1 plot	7	Kona
Bamboo	Hexazinone (pellets)	1 pellet/m	Soil	20	1 plot	4	Kona
Bamboo (re-sprouts)	Imazapyr	0.5	Drizzle foliar	20	1 plot	7	Kona
Bamboo	Imazapyr	9 %	Basal	50	1 plot	7	Kona
Black wattle	Triclopyr ester	15%	VLV BB	70	3	5	Boundary Trail
Christmasberry (stumps)	Triclopyr-Pathfinder II	15%	VLV	100	6	7	Kona
Fayatree	Triclopyr ester	15%	VLV BB	50	2	5	Boundary Trail
Lantana	Glyphosate	50%	BB	90	10	4	Kona
Lantana	Hexazinone	2 kg/ha	Drizzle	99	1 plot	4	Kona
Lantana	Hexazinone	1 pellet	Soil	100	11	4	Kona
Lantana	Tebuthiuron	2 lb/a	Soil	100	2 plots	24	Kaupo
Lantana	Tebuthiuron	2 kg/ha	Soil	100	1 plot	4	Kona
Lantana	Tebuthiuron	4 kg/ha	Soil	100	1 plot	4	Kona
Pickleweed	Glyphosate	1 kg/ha	Drizzle	80	1 plot	1	Kohanaiki
Pickleweed	MCPA	0.5 kg/ha	Drizzle	50	2 plots	1	Kohanaiki
Pickleweed	Triclopyr	0.5 kg/ha	Drizzle	75	1 plot	1	Kohanaiki
Pickleweed	Triclopyr/oil	0.5 kg/ha	Drizzle	77	1 plot	1	Kohanaiki
Rubus niveus	Triclopyr	15%	Drizzle	92	2 plots	5	Waiohuli Trail
Rubus niveus	Triclopyr	15%	VLV BB	92	2 plots	5	Waiohuli Trail